Big Jack East Fire Behavior Modeling process for current conditions and post treatment conditions.

The objective of this document is to provide a record of the fire behavior modeling performed for potential fire behavior of the current condition in the Big Jack East project. A description of the process, basic assumptions, and display of relevant outputs are shown in this document.

Data and Modeling Used for Big Jack East

It was determined for Big Jack East Project that the most accurate and current fuels data to use for modeling is the LANDFIRE 2014 data (www.landfire.gov). The fuel models described below are taken from the LANDFIRE dataset.

The BehavePlus5 Fire Behavior Modeling system was used to predict fire behavior. Fuel models descriptions were derived from General Technical Report RMRS-GTR-153, June 2005, Standard Fire Behavior Fuel Models: A Comprehensive Set for Use with Rothermel's Surface Fire Spread Model.

Current Fuel Models

Since a forest is a dynamic environment, the entire Big Jack East Project of 2,059 acres, can be divided into 13 fuels models including unburnable fuel model. These 13 fuel models are shown in the table below. Four fuel models represent a majority of the project area. These four fuel models have been used to represent the project area in the model runs. What will be displayed is the fire behavior that most represents each treatment. The four fuels models that are used for the modeling are highlighted below. All data is derived from General Technical Report RMRS-GTR-153, June 2005, Standard Fire Behavior Fuel Models: A Comprehensive Set for Use with Rothermel's Surface Fire Spread Model.

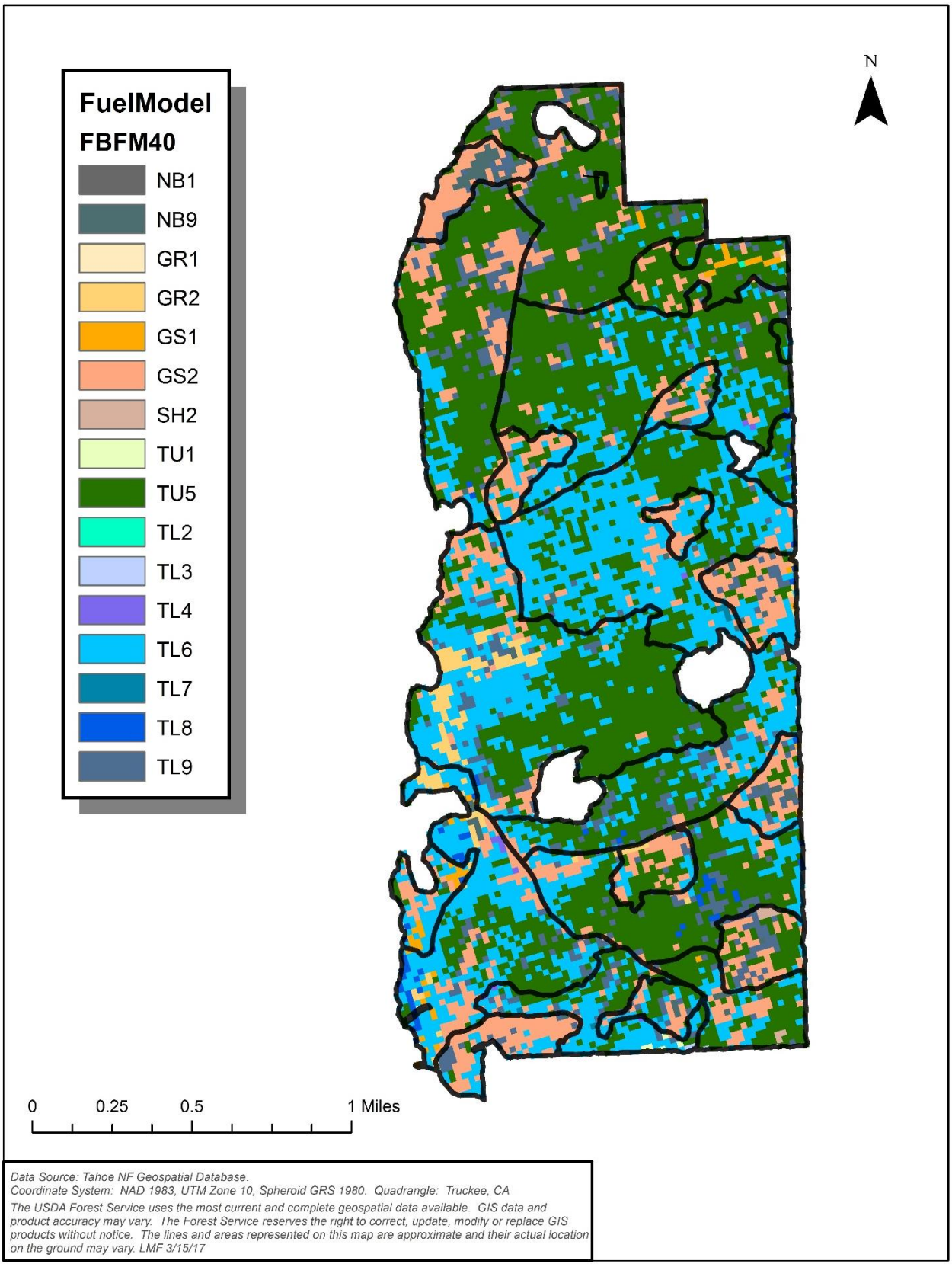
Table 1 Current Fuel Models

Fuel Models throughout the entire project area	Acres within project area	Percent of project area	Flame length in feet	Rate of Spread in chains per hour	Fire Type
Unburnable areas such as rock screes, lakes, snow or ice	44	2.14%	0	0	Non Burnable
GR2 (102) Low Load, Dry Climate Grass (Dynamic). The Primary carrier of fire in GR2 is grass, though small amounts of fine dead fuel may be present. Load is greater than GR1, and fuel bed may be more continuous. Shrubs, if present, do not affect fire behavior.	30	1.46%	7.3	79	Passive Crown Fire
GS1 (121) Low Load, Dry Climate Grass-Shrub (Dynamic). The primary carrier of fire in GS1 is grass and shrubs combined. Shrubs are about 1 foot high, grass load is low. Spread rates are moderate; flame length low. Moisture of extinction is low.	12	0.58%	5	28.8	Passive Crown Fire

GS2 (122) Moderate Load, Dry Climate Grass-Shrub (Dynamic). The primary carrier of fire in GS2 is grass and shrubs combined. Shrubs are about 1 to 3 feet high, grass load is moderate. Spread rate is high; flame length moderate. Moisture of extinction is low.	290	14.08%	7.3	39.7	Passive Crown Fire
SH2 (142) Moderate Load, Dry Climate Shrub. The primary carrier of fire in SH2 is woody shrubs and shrub litter. Moderate fuel load depth of about 1 foot, no grass fuel present. Spread rate is low; flame length low.	3	0.15%	6.2	10.9	Passive Crown Fire
TU1 (161) Low Load Dry Climate Timber-Grass-Shrub (Dynamic). The primary carrier of fire in TU1 is low load of grass and/or shrub with litter. Spread rate is low; flame length low.	1	0.05%	2.5	4.7	Surface Fire
TU5 (165) Very High Load, Dry Climate Timber-Shrub. The primary carrier of fire in TU5 is heavy forest litter with a shrub or small tree understory. Spread rate is moderate; flame length moderate.	937	45.51%	9.7	14	Passive Crown Fire
TL3 (183) Moderate Load Conifer Litter. The primary carrier of fire in TL3 is moderate load conifer litter, light load of course fuels. Spread rate is low; flame length is low.	1	0.05%	1.4	2.7	Surface Fire
TL4 (184) Small Downed logs. The primary carrier of fire in TL4 is moderate load of fine litter and coarse fuels and includes small diameter downed logs. Spread rate is low; flame length is low.	2	0.10%	1.8	3.8	Surface Fire
***TL6 (186) Moderate Load Broadleaf Litter.** The primary carrier of fire in TL6 is moderate load broadleaf litter, less compact than TL2. Spread rate is moderate; flame length low.	573	27.83%	3.8	9.5	Surface Fire
TL7 (184) Large Downed Logs. The primary carrier of fire in TL7 is heavy load forest litter, includes larger diameter downed logs. Spread rate low; flame length low.	2	0.10%	2.6	4.2	Surface Fire
TL8 (188) Long Needle Litter. The primary carrier of fire in TL8 is moderate load long-needle pine litter, may include small amount of herbaceous load. Spread rate is moderate; flame length is low.	14	0.68%	4.5	9.3	Surface Fire
***TL9 (189) High Load Broad leaf Litter.** The Primary carrier of fire in TL9 is very high load, fluffy broad leaf litter. TL9 can often be used to represent heavy needle drape. Spread rate is moderate; Flame length is moderate.	150	7.29%	6.5	13.9	Passive Crown Fire

* The broadleaf litter fuel model as run in BehavePlus represents the best response for the combination of timber litter, shrub littler, and long needle pine that is in the project area.

Map 1 Big Jack East Fuel Model Map, GS2, TU5, TL6 and TL9 were the majority of fuel models portrayed



Current descriptors for the main four fuel models

Grass-Shrub Fuel Type Models (GS)

The primary carrier of fire in the GS fuel models is grass and shrubs combined; both components are important in determining fire behavior.

All GS fuel models are dynamic, meaning that their live herbaceous fuel load shifts from live to dead as a function of live herbaceous moisture content. The effect of live herbaceous moisture content on spread rate and intensity is strong and depends on the relative amount of grass and shrub load in the fuel model. The vegetation is under 3 feet in height.

GS2 (122) Moderate Load, Dry Climate Grass-Shrub (Dynamic). The primary carrier of fire in GS2 is grass and shrubs combined. Shrubs are about 1 to 3 feet high, grass load is moderate. Spread rate is high; flame length moderate. Moisture of extinction is low.	**Acres within project area**	**Percent of project area**	**Flame length in feet**	**Rate of Spread in chains per hour**	**Fire Type**
	290	14.08%	7.3	39.7	Passive Crown Fire

The grass shrub model would most likely be masticated and burned in this project. This model does not appear in every unit, its limited to portions in a handful of units. There may be areas where grass will still be present however the shrub model would change. The Fuels Report discusses the modeling of this fuel type is in greater detail.

Timber-Understory Fuel Type Models (TU)

TU5 (165) Very High Load, Dry Climate Timber-Shrub. The primary carrier of fire in TU5 is heavy forest litter with a shrub or small tree understory. Spread rate is moderate; flame length moderate.	**Acres within project area**	**Percent of project area**	**Flame length in feet**	**Rate of Spread in chains per hour**	**Fire Type**
	937	45.51%	9.7	14	Passive Crown Fire

The primary carrier of fire in the TU fuel models is forest litter in combination with herbaceous or shrub fuels. TU1 and TU3 contain live herbaceous load and are dynamic, meaning that their live herbaceous fuel load is allocated between live and dead as a function of live herbaceous moisture content. The effect of live herbaceous moisture content on spread rate and intensity is strong and depends on the relative amount of grass and shrub load in the fuel model.

The Timber Understory fuel model covers over 45% of the project area. Most of the project area has a high load of shrubs such as manzanita, snow brush, bitter brush and sagebrush.

Timber Litter Fuel Type Models (TL)

The primary carrier of fire in the TL fuel models is dead and down woody fuel. Live fuel, if present, has little effect on fire behavior.

***TL6 (186) Moderate Load Broadleaf Litter.** The primary carrier of fire in TL6 is moderate load broadleaf litter, less compact than TL2. Spread rate is moderate; flame length low.	**Acres within project area**	**Percent of project area**	**Flame length in feet**	**Rate of Spread in chains per hour**	**Fire Type**
	573	27.83%	3.8	9.5	Surface Fire

Although there is no broadleaf litter in the project area, mixed conifer/pine forests can burn like this. 573 acres within the project area are already inventoried as this fuel type. On the ground this fuel is a blend of mixed conifer litter, shrub litter, and long needle pine.

Timber Litter Fuel Type Models (TL)

The primary carrier of fire in the TL fuel models is dead and down woody fuel. Live fuel, if present, has little effect on fire behavior.

***TL9 (189) High Load Broad leaf Litter.** The Primary carrier of fire in TL9 is very high load, fluffy broad leaf litter. TL9 can often be used to represent heavy needle drape. Spread rate is moderate; Flame length is moderate.	**Acres within project area**	**Percent of project area**	**Flame length in feet**	**Rate of Spread in chains per hour**	**Fire Type**
	150	7.29%	6.5	13.9	Passive Crown Fire

Although there is no broadleaf litter in the project area, mixed conifer/pine forests can burn like this. 150 acres within the project area are already inventoried as this fuel type. On the ground this fuel is a blend of mixed conifer litter, shrub litter, and long needle pine.

Post Treatment fuel model conversion

Below is how I interpreted fire behavior after each treatment is complete. It was difficult to choose one since there are so many variables throughout the entire project. I used a combination of two models to display fire behavior post treatment. Below are the examples of each model. There may be a portion of the grass/shrub model remaining in some units post treatment. The post treatment fuel model has some form of fine fuel in it which would take the place of the grass/shrub model. All fire behavior is modeled with the 90th percentile weather conditions.

Table 2 Post treatment fuel model conversion

Current Fuel Model	Fuel treatment	Post treatment fuel model conversion	Flame length in feet	Rate of Spread in chains per hour	Fire Type
GS2, TU5, TL6, TL9	Grapple pile burn	75% TL6	3.8	9.5	Surface Fire
		25% TL1	.8	1.4	Surface Fire
GS2, TU5, TL6, TL9	Mastication	50% SB1	4.2	9.7	Surface Fire
		50% TL5	2.9	7	Surface Fire
GS2, TU5, TL6, TL9	Hand pile burn	50% TL8	4.5	9.3	Surface Fire
		50% TL6	3.8	9.5	Surface Fire
GS2, TU5, TL6, TL9	Jackpot Burn	50% TL1	.8	1.4	Surface Fire
		50% TL6	3.8	9.5	Surface Fire
GS2, TU5, TL6, TL9	Underburn	50% TL1	.8	1.4	Surface Fire
		50% TL3	1.4	2.7	Surface Fire

Grapple Pile

25% TL1 (181) Low Load Compact Conifer Litter

75% TL6 (186) Moderate Load Broadleaf Litter

Although there is no broadleaf litter in the project area, mixed conifer/pine forests can burn like this. 573 acres within the project area have been identified as this fuel type. On the ground this fuel type is a mix of shrub litter, timber litter and long needle pine.

Mastication

50% SB1 (201) Low Load Activity Fuel below

50% TL5 (185) High Load Conifer Litter below

Hand Pile and Burn

50% TL8 (188) Long-Needle Litter

50% TL6 (186) Moderate Load Broadleaf Litter

Although there is no broadleaf litter in the project area, mixed conifer/pine forests can burn like this. 573 acres within the project area have been identified as this fuel type. On the ground this fuel type is a mix of shrub litter, timber litter and long needle pine.

TL3 would have been another choice which is a moderate load mixed conifer litter but the flame lengths and ROS seemed too low therefore the TL6 is the best model for what is on the ground.

Jackpot Burn

50% TL1 (181) Low Load Compact Conifer Litter

50% TL6 (186) Moderate Load Broadleaf Litter

Underburn

50% TL1 (181) Low Load Compact Conifer Litter

50% TL3 (183) Moderate Load Conifer Litter

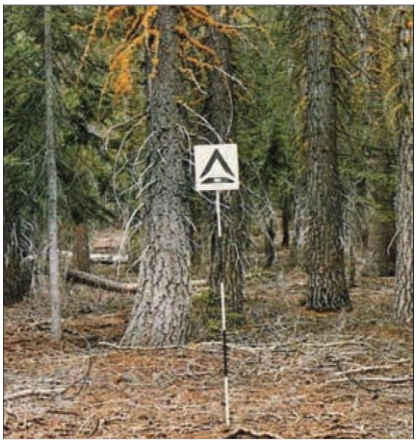


Table 3 Fuel model Parameters

Fuel model code	Fuel load (t/ac)					Fuel model type[a]	SAV ratio (1/ft)[b]			Fuel bed depth (ft)	Dead fuel extinction moisture (percent)	Heat content BTU/lb)[c]
	1-hr	10-hr	100-hr	Live herb	Live woody		Dead 1-hr	Live herb	Live woody			
GR1	0.10	0.00	0.00	0.30	0.00	dynamic	2200	2000	9999	0.4	15	8000
GR2	0.10	0.00	0.00	1.00	0.00	dynamic	2000	1800	9999	1.0	15	8000
GR3	0.10	0.40	0.00	1.50	0.00	dynamic	1500	1300	9999	2.0	30	8000
GR4	0.25	0.00	0.00	1.90	0.00	dynamic	2000	1800	9999	2.0	15	8000
GR5	0.40	0.00	0.00	2.50	0.00	dynamic	1800	1600	9999	1.5	40	8000
GR6	0.10	0.00	0.00	3.40	0.00	dynamic	2200	2000	9999	1.5	40	9000
GR7	1.00	0.00	0.00	5.40	0.00	dynamic	2000	1800	9999	3.0	15	8000
GR8	0.50	1.00	0.00	7.30	0.00	dynamic	1500	1300	9999	4.0	30	8000
GR9	1.00	1.00	0.00	9.00	0.00	dynamic	1800	1600	9999	5.0	40	8000
GS1	0.20	0.00	0.00	0.50	0.65	dynamic	2000	1800	1800	0.9	15	8000
GS2	0.50	0.50	0.00	0.60	1.00	dynamic	2000	1800	1800	1.5	15	8000
GS3	0.30	0.25	0.00	1.45	1.25	dynamic	1800	1600	1600	1.8	40	8000
GS4	1.90	0.30	0.10	3.40	7.10	dynamic	1800	1600	1600	2.1	40	8000
SH1	0.25	0.25	0.00	0.15	1.30	dynamic	2000	1800	1600	1.0	15	8000
SH2	1.35	2.40	0.75	0.00	3.85	N/A	2000	9999	1600	1.0	15	8000
SH3	0.45	3.00	0.00	0.00	6.20	N/A	1600	9999	1400	2.4	40	8000
SH4	0.85	1.15	0.20	0.00	2.55	N/A	2000	1800	1600	3.0	30	8000
SH5	3.60	2.10	0.00	0.00	2.90	N/A	750	9999	1600	6.0	15	8000
SH6	2.90	1.45	0.00	0.00	1.40	N/A	750	9999	1600	2.0	30	8000
SH7	3.50	5.30	2.20	0.00	3.40	N/A	750	9999	1600	6.0	15	8000
SH8	2.05	3.40	0.85	0.00	4.35	N/A	750	9999	1600	3.0	40	8000
SH9	4.50	2.45	0.00	1.55	7.00	dynamic	750	1800	1500	4.4	40	8000
TU1	0.20	0.90	1.50	0.20	0.90	dynamic	2000	1800	1600	0.6	20	8000
TU2	0.95	1.80	1.25	0.00	0.20	N/A	2000	9999	1600	1.0	30	8000
TU3	1.10	0.15	0.25	0.65	1.10	dynamic	1800	1600	1400	1.3	30	8000
TU4	4.50	0.00	0.00	0.00	2.00	N/A	2300	9999	2000	0.5	12	8000
TU5	4.00	4.00	3.00	0.00	3.00	N/A	1500	9999	750	1.0	25	8000
TL1	1.00	2.20	3.60	0.00	0.00	N/A	2000	9999	9999	0.2	30	8000
TL2	1.40	2.30	2.20	0.00	0.00	N/A	2000	9999	9999	0.2	25	8000
TL3	0.50	2.20	2.80	0.00	0.00	N/A	2000	9999	9999	0.3	20	8000
TL4	0.50	1.50	4.20	0.00	0.00	N/A	2000	9999	9999	0.4	25	8000
TL5	1.15	2.50	4.40	0.00	0.00	N/A	2000	9999	1600	0.6	25	8000
TL6	2.40	1.20	1.20	0.00	0.00	N/A	2000	9999	9999	0.3	25	8000
TL7	0.30	1.40	8.10	0.00	0.00	N/A	2000	9999	9999	0.4	25	8000
TL8	5.80	1.40	1.10	0.00	0.00	N/A	1800	9999	9999	0.3	35	8000

TL9	6.65	3.30	4.15	0.00	0.00	N/A	1800	9999	1600	0.6	35	8000
SB1	1.50	3.00	11.00	0.00	0.00	N/A	2000	9999	9999	1.0	25	8000
SB2	4.50	4.25	4.00	0.00	0.00	N/A	2000	9999	9999	1.0	25	8000
SB3	5.50	2.75	3.00	0.00	0.00	N/A	2000	9999	9999	1.2	25	8000
SB4	5.25	3.50	5.25	0.00	0.00	N/A	2000	9999	9999	2.7	25	8000

Plantations

Plantations were treated differently in the fire behavior modeling process. The ideal treatment for the plantations would be biomass removal and/or mastication. For post treatment conditions a custom model sb1 was used as well as tl5. The custom fuel model was sb1 but with a lowered fuel bed depth. The fuel bed depth was lowered to 0.9 from 1 foot, as it was difficult to theorize that an entire foot of masticated material would be left on the ground.

Table 4 Current Conditions for Plantations

Fuel Model	ROS (max)	Flame Length	Critical Surf Int	Transition to Crown?	Crown Fire ROS	Critical Crown ROS	Active Crown?	Fire Type	Prob of Mortality
	ch/h	ft	Btu/ft/s		ch/h	ch/h			%
tu5	14.0	9.7	23	Yes	67.7	159.6	No	Passive Crown Fire	80
gs2	39.7	7.3	23	Yes	67.7	159.6	No	Passive Crown Fire	80

Table 5 Plantations post treatment

Fuel Model	ROS (max)	Flame Length	Critical Surf Int	Transition to Crown?	Crown Fire ROS	Critical Crown ROS	Active Crown?	Fire Type	Prob of Mortality
	ch/h	ft	Btu/ft/s		ch/h	ch/h			%
Custom sb1	8.4	3.8	120	No	67.7	328.6	No	Surface Fire	16
tl5	7.0	2.9	120	No	67.7	328.6	No	Surface Fire	7